CLAIMS

1. A method of sampling a multi-phase fluid stream comprising the steps of:

sampling, with a sampling probe, a portion of the fluid stream;

measuring the flow rate Q_S of said sampled portion; and

measuring, independently of the sampling step, the total flow rate Q of the fluid stream,

wherein the flow rate of the sampled portion is controlled according to the ratio of the flow rate of the sampled portion to the flow rate of the fluid stream, in order to obtain substantially isokinetic sampling of the fluid stream.

2. A method according to claim 1 wherein the flow rate of the sampled portion is controlled such that the equation $\frac{Q_S}{Q} = \frac{A_{probe}}{A_{pipe}}$ is satisfied to within 10%, where A_{probe} and A_{pipe} are the respective cross-sectional areas of the sampling probe opening and the fluid stream at the sampling point.

3. A method according to claim 2 wherein the equation is satisfied to within 5%.

4. A method according to any one of claims 1 to 3 wherein the flow rates Q and Q_S are mass flow rates.

5. A method according to any one of claims 1 to 4 wherein the flow rate Q_S of the sampled portion of the fluid stream is less than 0.2% of the total flow rate Q.

6. A method according to claim 5 wherein the sampled flow rate Q_S is less than 0.05% of the total flow rate Q.

7. A method according to any one of claims 1 to 6 wherein the gas flow rate is at least 5 MMscf/d.

8. A method according to any preceding claim further including the step of separating said sampled portion into a sampled liquid flow and a sampled gas flow, and wherein said step of measuring the sampled flow rate includes measuring the flow rate of the sampled liquid flow and the flow rate of the sampled gas flow.

9. A method according to claim 8 wherein the flow rate of the sampled liquid flow or of the sampled gas flow is measured using a Coriolis flow meter.

10. A method according to any one of the preceding claims wherein the step of measuring the total flow rate includes measuring the density of the fluid stream.

11. A method according to any one of the preceding claims wherein the step of measuring the total flow rate includes measuring a differential pressure.

12. A method according to claim 11 wherein said differential pressure is measured using a Venturi meter.

13. A method according to claim 11 wherein said differential pressure is an impact pressure measured using a Pitot tube.

14. A method according to any one of the preceding claims wherein said step of measuring the total flow rate is carried out continuously during the sampling process.

15. A method according to any one of the preceding claims wherein the step of controlling the flow rate of the sampled portion is carried out continuously during the sampling process.

16. A method according to any preceding claim wherein the fluid stream is a feed from a well-head.

17. A method according to claim 16 wherein the method is carried out at a well-head site.

18. A method according to any one of the preceding claims further including, prior to sampling the fluid stream, the step of conditioning the fluid stream.

19. A method according to claim 18, wherein said step of conditioning the fluid stream includes the sub-steps of successively:

forming a liquid film at the wall of a pipe section which carries the fluid stream;

straightening the flow of at least the core of the fluid stream; and

shedding the liquid film into said core.

20. A method according to claim 19 wherein an orifice plate is used to shed the liquid film into the core of the fluid stream.

21. A method according to claim 20 wherein two orifice plates are used to shed the liquid film into the core of the fluid stream.

22. A method according to claim 20 or claim 21 wherein the or each orifice plate has an open diameter of 0.85 to 0.95 of the local diameter of the pipe section.

23. A method according to claim 22 wherein the or each orifice plate has an open diameter of 0.9 to 0.95 of the local diameter of the pipe section.

24. A method according to any one of claims 20 to 23 wherein the step of sampling is performed at a distance between 1D and 3D downstream of the downstream orifice plate, where D is the local diameter of the pipe section at said downstream orifice plate.

25. A method according to any one of claims 20 to 24 wherein the pipe section narrows at the orifice plate.

26. A method according to any one of claims 19 to 25 wherein the sub-step of forming the liquid film includes causing the fluid stream to swirl about the axis of the pipe section.

27. A method according to claim 26 wherein the fluid stream is caused to swirl by tangentially introducing the fluid stream to the pipe section.

28. A method according to claim 26 wherein the fluid stream is caused to swirl by passing the fluid stream through a helical insert inside the pipe section.

29. A method according to any one of the preceding claims wherein the step of sampling is performed at the centre of a pipe section in which the fluid stream is flowing.

30. Sampling apparatus for sampling a multi-phase fluid stream, comprising:

means for measuring the total flow rate Q of the fluid stream;

a sampling probe for sampling a portion of said fluid stream;

a meter for measuring the flow rate Q_S of said sampled portion; and

a controller adapted to control the flow rate of the sampled portion according to the ratio of the flow rate of the sampled portion to the total flow rate of the fluid stream, in order to obtain substantially isokinetic sampling of the fluid stream.

31. Apparatus according to claim 30 wherein the controller is adapted to control the flow rate of the sampled portion such that the equation $\frac{Q_S}{Q} = \frac{A_{probe}}{A_{pipe}}$ is satisfied to within 10%, where A_{probe} and A_{pipe} are the

respective cross-sectional areas of the sampling probe opening and the fluid stream at the sampling point.

32. Apparatus according to claim 31 wherein the equation is satisfied to within 5%.

33. Apparatus according to any one of claims 30 to 32 wherein the flow rates Q and Q_S are mass flow rates, and the meter is a mass flow rate meter.

34. Apparatus according to any one of claims 30 to 33 wherein the cross-sectional area of the sampling probe opening is less than 0.2% of the cross-sectional area of the fluid stream at the sampling point.

35. Apparatus according to claim 34 wherein the cross-sectional area of the sampling probe opening is less than 0.05% of the cross-sectional area of the fluid stream at the sampling point.

36. Apparatus according to any one of claims 30 to 35 wherein the gas flow rate is at least 5 MMscf/d.

37. Apparatus according to any one of claims 30 to 36 further including a separator for separating said sampled portion into a sampled liquid flow and a sampled gas flow; a meter for measuring the flow rate of the sampled liquid flow; and a meter for measuring the flow rate of the sampled gas flow.

38. Apparatus according to claim 37 wherein either of both of said meters are Coriolis flow meters.

39. Apparatus according to any one of claims 30 to 38 wherein the means for measuring the total flow rate includes a densitometer for measuring the density of the fluid stream.

40. Apparatus according to any one of claims 30 to 39 wherein the means for measuring the total flow rate includes a differential pressure sensor.

41. Apparatus according to claim 40 wherein said differential pressure sensor is for use with a Venturi meter.

42. Apparatus according to claim 40 wherein said differential pressure sensor is for use with a Pitot tube.

43. Apparatus according to any one of claims 30 to 42 wherein said means for measuring the total flow rate operates continuously during the sampling process.

44. Apparatus according to any one of claims 30 to 43 wherein the controller controls the flow rate of the sampled portion continuously during the sampling process.

45. Apparatus according to any one of claims 30 to 44 wherein the fluid stream is a feed from a well-head.

46. Apparatus according to any one of claims 30 to 45 further including, upstream of said sampling probe, a flow conditioner.

47. Apparatus according to claim 46 wherein said flow conditioner is a pipe section including:

a swirl inducing section;

a flow straightener; and

an orifice plate.

48. Apparatus according to claim 47 wherein said swirl inducing section includes a tangential input to the pipe section.

49. Apparatus according to claim 47 wherein said swirl inducing section includes a helical insert inside the pipe section.

50. Apparatus according to any one of claims 47 to 49 wherein said flow straightener is located in the centre of the pipe section and such that there is an annular gap between said flow straightener and the wall of the pipe section.

51. Apparatus according to any one of claims 47 to 50 wherein said orifice plate has an open diameter of 0.85 to 0.95 of the local diameter of the pipe section.

52. Apparatus according to claim 51 wherein said orifice plate has an open diameter of 0.9 to 0.95 of the local diameter of the pipe section.

53. Apparatus according to any one of claims 47 to 52 wherein the pipe section narrows at the orifice plate.

54. Apparatus according to any one of claims 47 to 53 further including a second orifice plate located downstream of the first orifice plate.

55. Apparatus according to any one of claims 47 to 54, wherein the sampling probe is located at a distance between 1D and 3D downstream of the downstream orifice plate, where D is the local diameter of the pipe section at said downstream orifice plate.

56. Apparatus according to any one of claims 30 to 55 wherein the sampling probe is located at the centre of a pipe section in which the fluid stream is flowing.

57. A method of conditioning the flow of a multi-phase fluid stream, comprising the steps of successively:

forming a liquid film at the wall of a pipe section which carries the fluid stream;

straightening the flow of at least a core of the fluid stream; and

shedding the liquid film into said core.

58. A method according to claim 57 wherein an orifice plate is used to shed the liquid film into the core of the fluid stream.

59. A method according to claim 58 wherein two orifice plates are used to shed the liquid film into the core of the fluid stream.

60. A method according to claim 58 or claim 59 wherein the or each orifice plate has an open diameter of 0.85 to 0.95 of the local diameter of the pipe section.

61. A method according to claim 60 wherein the or each orifice plate has an open diameter of 0.9 to 0.95 of the local diameter of the pipe section.

62. A method according to any one of claims 58 to 61 wherein the pipe section narrows at the orifice plate.

63. A method according to any one of claims 57 to 62 wherein the sub-step of forming the liquid film includes causing the fluid stream to swirl about the axis of the pipe section.

64. A method according to claim 63 wherein the fluid stream is caused to swirl by tangentially introducing the fluid stream to the pipe section.

65. A method according to claim 64 wherein the fluid stream is caused to swirl by passing the fluid stream through a helical insert inside the pipe section.

66. A method according to any one of claims 58 to 65, further including the step of sampling the fluid stream using a sampling probe, wherein said step of sampling is performed at a distance between 1D and 3D downstream of the downstream orifice plate, where D is the local diameter of the pipe section at said downstream orifice plate.

67. A method according to claim 66 wherein the step of sampling is performed at the centre of a pipe section in which the fluid stream is flowing.

68. A method according to any one of claims 57 to 65 further including the step of sampling the fluid stream using a sampling probe, wherein the step of sampling is performed at the centre of a pipe section in which the fluid stream is flowing.

69. A flow conditioner for a wellhead sampling system, the flow conditioner being a pipe section including:

a swirl inducing section;

a flow straightener; and

an orifice plate.

70. A flow conditioner according to claim 69 wherein said swirl inducing section includes a tangential input to the pipe section.

71. A flow conditioner according to claim 69 wherein said swirl inducing section includes a helical insert inside the pipe section.

72. A flow conditioner according to any one of claims 69 to 71 wherein said flow straightener is located in the centre of the pipe section and such that there is an annular gap between said flow straightener and the wall of the pipe section.

73. A flow conditioner according to any one of claims 69 to 72 wherein said orifice plate has an open diameter of 0.85 to 0.95 of the local diameter of the pipe section.

74. A flow conditioner according to claim 73 wherein said orifice plate has an open diameter of 0.9 to 0.95 of the local diameter of the pipe section.

75. A flow conditioner according to any one of claims 69 to 74 wherein the pipe section narrows at the orifice plate.

76. A flow conditioner according to any one of claims 69 to 75 further including a second orifice plate located downstream of the first orifice plate.

77. A flow conditioner according to any one of claims 69 to 76, further including a sampling probe located downstream of the orifice plate.

78. A flow conditioner according to claim 77 wherein the sampling probe is located at a distance between 1D and 3D downstream of the downstream orifice plate, where D is the local diameter of the pipe section at said downstream orifice plate.

79. A flow conditioner according to claim 77 or claim 78 wherein the sampling probe is located at the centre of a pipe section in which the fluid stream is flowing.